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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/934,105	08/21/2001	Wendell H. Mills JR.	C000410	7661

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EXAMINER	
WEST, JEFFREY R	
ART UNIT	**PAPER NUMBER**
2857	

DATE MAILED: 08/18/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/934,105	Applicant(s) MILLS, WENDELL H.
	Examiner Jeffrey R. West	Art Unit 2857

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Peri d f r Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *11 December 2002* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-17* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-17* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *21 August 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 2 .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Specification

1. The disclosure is objected to because of the following informalities in the presented equations:

In the equation $E=\sum_{\#datasets}\left[\sum_{Curves\ C}(J_{net}(u))^2\right]+\gamma\sum_{k,j=1}^{M-2,N-2}\left[(\nabla_x^3\rho_x)^2+(\nabla_y^3\rho_x)^2\right]$, the third level minimization term includes the values of $\left[\left(\nabla_x^3\rho_x\right)^2+\left(\nabla_y^3\rho_x\right)^2\right]$. Since it is well known in the art that the SI unit for ρ is Ω-m, the equation will result in units of Ω-m/m^3, or Ω/m^2, for $\left(\nabla_x^3\rho_x\right)^2$ and $\left(\nabla_y^3\rho_x\right)^2$, thereby producing an SI unit of Ω/m^4 for $\left[\left(\nabla_x^3\rho_x\right)^2+\left(\nabla_y^3\rho_x\right)^2\right]$. The equation $E=\sum_{\#datasets}\left[\sum_{Curves\ C}(J_{net}(u))^2\right]+\gamma\sum_{k,j=1}^{M-2,N-2}\left[(\nabla_x^3\rho_x)^2+(\nabla_y^3\rho_x)^2\right]$ then adds the value of $\left[\left(\nabla_x^3\rho_x\right)^2+\left(\nabla_y^3\rho_x\right)^2\right]$ to a value for $\sum(J_{net}(u))^2$. However, since J_{net} (i.e. current density) is well-known to have a unit of A/m^2, squared in the equation to have a unit of A/m^4, it is unclear how the equation can add values in units of Ω/m^4 with values in units of A/m^4. A similar line of reasoning applies to the second order

equation $E = \sum_{\#datasets}\left[\sum_{Curves\,C}(J_{net}(u))^2\right] + \gamma \sum_{k,j=1}^{M-1,N-1}\left[(\nabla_x^2\rho_x)^2 + (\nabla_y^2\rho_x)^2\right]$, which would result in the addition of values in units of Ω/m^2 with values in units of A/m^4.

Secondly, the second and third order equations for performing regularization include summations $\sum_{k,j=1}^{M-1,N-1}\left[(\nabla_x^2\rho_x)^2 + (\nabla_y^2\rho_x)^2\right]$ and $\sum_{k,j=1}^{M-2,N-2}\left[(\nabla_x^3\rho_x)^2 + (\nabla_y^3\rho_x)^2\right]$, respectively. These summations are defined from values of k and j to values of M and N. The elements of the summation, however, are not dependent on j or k.

Thirdly, in the equations $\frac{\rho_{x1} - 2\rho_{x2} + \rho_{x3}}{\Delta x^2} \approx \nabla_x^2\rho_x$ and $\frac{-\rho_{x1} + 3\rho_{x2} - 3\rho_{x3} + \rho_{x4}}{\Delta x^3} \approx \nabla_x^3\rho_x$, the denominators should be re-written as $(\Delta x)^2$ and $(\Delta x)^3$, respectively, in order to insure that these values are not interpreted as $\Delta(x^2)$ and $\Delta(x^3)$.

Appropriate correction is required.

Claim Objections

2. Claims 3, 7, 12, and 15 are objected to because of the following informalities:

In claim 3, "said acceptable value for E is identical with the error in voltage measurement" should be ---said acceptable value for E is identical to an error in the voltage measurement---.

In claims 7, 10, 12, and 15, in equations $\frac{\rho_{x1} - 2\rho_{x2} + \rho_{x3}}{\Delta x^2} \approx \nabla_x^2 \rho_x$ and $\frac{-\rho_{x1} + 3\rho_{x2} - 3\rho_{x3} + \rho_{x4}}{\Delta x^3} \approx \nabla_x^3 \rho_x$, the denominators should be re-written as $(\Delta x)^2$ and $(\Delta x)^3$, respectively, in order to insure that these values are not interpreted as $\Delta(x^2)$ and $\Delta(x^3)$.

Appropriate correction is required.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

4. Claims 1-17 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

Claim 1 recites "applying said voltage drops Δu as known variable inputs to an equation that models the ohmic material in two dimensions according to physical laws, said equation also including terms representative of a plurality of unknown resistivities and having a solution equal to zero if said equation contains accurate values of said unknown resistivities and no error E is present." From the

specification, and further limiting claim 2, the equation is defined as

$$J_{net}(u) = \oint_C i(s)d\mathbf{n} - S_C = \oint_C \frac{1}{\rho_r}\left(\frac{du}{ds_n}\right)_r ds - S_C = 0$$

. Claim 1 then adds a further limitation of "adding a regularization term to said equation, said regularization term comprising a selected regularization constant γ multiplied by a third level error minimization term." The specification, however, does not sufficiently enable this step. The specification does provide the equation

$$E = \sum_{\#datasets}\left[\sum_{Curves\ C}(J_{net}(u))^2\right] + \gamma \sum_{k,j=1}^{M-2,N-2}\left[(\nabla_x^3\rho_x)^2 + (\nabla_y^3\rho_x)^2\right]$$

, but this equation does not add a regularization term to the equation defined above, but uses the equation and the regularization term in an overall regularization model. Since the specification does not describe the claimed limitation, it is unclear to one having ordinary skill in the art how to make/use this aspect of the invention.

Claim 17 is rejected as lacking enablement because it includes a similar limitation reciting, "said step of regularization includes adding a regularization term to said equation". As noted above, this limitation is unclear to one having ordinary skill in the art because "said equation" is used in combination with a regularization term; a regularization term is not added to "said equation."

Claims 1, 11, and 16 are further rejected under 35 U.S.C. 112, first paragraph, because claim 1 recites, "incorporating said equation and said third level error minimization term into a least squares minimization model and using computer-based numerical methods to solve for values of resistivity that result in a global

solution to the least squares minimization model below said acceptable value of E" and claims 11 and 16 provide limitations for "regularizing an optimization of a sheet resistivity calculation . . . comprising a regularization constant γ multiplied by a third level error minimization term" and "regularizing said model to stabilize a value of said unknown resistivities calculated using said model." These steps are not sufficiently described in the specification for one having ordinary skill in the art to use the invention because the specification describes performing the regularization using the regularization model $E = \sum_{\#datasets}\left[\sum_{Curves\ C}(J_{net}(u))^2\right] + \gamma \sum_{k,j=1}^{M-2,N-2}\left[(\nabla_x^3 \rho_x)^2 + (\nabla_y^3 \rho_x)^2\right]$, but it is unclear how this model is used.

First, in the equation $E = \sum_{\#datasets}\left[\sum_{Curves\ C}(J_{net}(u))^2\right] + \gamma \sum_{k,j=1}^{M-2,N-2}\left[(\nabla_x^3 \rho_x)^2 + (\nabla_y^3 \rho_x)^2\right]$, the third level minimization term includes the values of $\left[\left(\nabla_x^3 \rho_x\right)^2 + \left(\nabla_y^3 \rho_x\right)^2\right]$. Since it is well known in the art that the SI unit for ρ is Ω-m, the equation will result in units of Ω-m/m^3, or Ω/m^2, for $\left(\nabla_x^3 \rho_x\right)^2$ and $\left(\nabla_y^3 \rho_x\right)^2$, thereby producing an SI unit of Ω/m^4 for $\left[\left(\nabla_x^3 \rho_x\right)^2 + \left(\nabla_y^3 \rho_x\right)^2\right]$. The equation $E = \sum_{\#datasets}\left[\sum_{Curves\ C}(J_{net}(u))^2\right] + \gamma \sum_{k,j=1}^{M-2,N-2}\left[(\nabla_x^3 \rho_x)^2 + (\nabla_y^3 \rho_x)^2\right]$ then adds the value of

$\left[\left(\nabla_x^3\rho_x\right)^2+\left(\nabla_y^3\rho_x\right)^2\right]$ to a value for $\Sigma(J_{net}(u))^2$. However, since J_{net} (i.e. current density) is well-known to have a unit of A/m^2, squared in the equation to have a unit of A/m^4, it is unclear how the equation can add values in units of Ω/m^4 with values in units of A/m^4. A similar line of reasoning applies to the second order equation $E=\sum_{\#datasets}\left[\sum_{Curves\,C}\Sigma(J_{net}(u))^2\right]+\gamma\sum_{k,j=1}^{M-1,N-1}\left[(\nabla_x^2\rho_x)^2+(\nabla_y^2\rho_x)^2\right]$, which would result in the addition of values in units of Ω/m^2 with values in units of A/m^4. Therefore, it is unclear to one having ordinary skill in the art how to carry out the claimed steps based upon the instant disclosure.

Secondly, the second and third order equations for performing regularization include summations $\sum_{k,j=1}^{M-1,N-1}\left[(\nabla_x^2\rho_x)^2+(\nabla_y^2\rho_x)^2\right]$ and $\sum_{k,j=1}^{M-2,N-2}\left[(\nabla_x^3\rho_x)^2+(\nabla_y^3\rho_x)^2\right]$, respectively. These summations are defined from values of k and j to values of M and N. The elements of the summation, however, are not dependent on j or k. Therefore, it is unclear to one having ordinary skill in the art how to carry out the summation and also unclear to one having ordinary skill in the art how to make/use the invention.

Claims 2-10 and 12-15 are rejected under 35 U.S.C. 112, first paragraph, because they incorporate the lack of enablement present in their respective parent claims.

5. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

6. Claims 5, 11-15, and 17 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 5 is rejected under 35 U.S.C. 112, second paragraph, because it contains the confusing language, "all terms in the error have equal accuracy." The error is not defined in parent claim 1 as having any "terms" and it is unclear what it means for the error terms to have equal accuracy.

Claim 11 is rejected as being vague and indefinite because it recites, "adding a regularization term to the calculation prior to optimization" while there is no previous mention of any "calculation." Further the limitation of "the calculation prior to optimization" does not distinctly claim any subject matter and it remains unclear to one having ordinary skill in the art what calculation is being performed.

Claim 17 is rejected as being vague and indefinaite because it recites, "adding a regularization term to said equation" while there is no previous mention of any "equation."

Claims 12-15 are rejected under 35 U.S.C. 112, second paragraph, because they incorporate the indefinite language of parent claim 11.

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure:

U.S. Patent Application Publication No. 2002/0138019 to Wexler et al. discloses a high definition electrical impedance tomography method comprising overlaying a surface of a medium to be analyzed with a matrix of nodes and imposing a known (0041) current to the matrix between current source and extraction (i.e. sink) points and measuring voltage at the nodes (0037). Wexler also discloses minimizing the error corresponding to the voltages (abstract) by supping the measured voltage drops between nodes (i.e. voltage potential Φ) to an equation that models the ohmic material under test according to physical laws, said equation also including terms representative of an unknown conductivity, k (0063-0069).

Wexler then discloses minimizing the error/regularizing the model through the use of a least squares best fit equation as a function of a regularization value, which is repetitively calculated and adjusted until a minimum/stable error is reached (0124 and 0134-0144).

While the invention of Wexler doesn't specifically disclose the equations

$$J_{net}(u) = \oint_C i(s) d\mathbf{n} - S_C = \oint_C \frac{1}{\rho_r}\left(\frac{du}{ds_n}\right)_r ds - S_C = 0$$

, these equations are an obvious modification of the equation of Wexler (i.e. J=k ∇ Φ). Firstly, Wexler assumes that the equation has a sum of all current sources/sinks equal to 0 (i.e. h(s)=0). This sum of all currents sources/sinks corresponds to S_C in the claimed

equation. Therefore, it would have been obvious to one having ordinary skill in the art to include a corresponding value for h(s)/SC if a source/sink current exists, in order to insure accurate results. Also, it is well known in the art that the conductivity, k, is the reciprocal of the resistivity ρ and the value of the gradient $\nabla\ \Phi$ is equal to d Φ/dn (see equation 2). Further, Wexler discloses calculating values for the variables over more than one dimension (0069-0076) but provides the equation $J=k\ \nabla\ \Phi$ as a general equation in one dimension. Modifying this equation to be in two dimensions (i.e. over a line or arc) would be performed by taking the line/closed integral with respect to the length of the line/arc which is well known to give a value of 0 due to Kirchoff's law (see, Sadiku, "Elements of Electromagnetics" and Caduceus MCAT Physics, "Kirchoff's Law").

U.S. Patent No. 3,995,213 to Robinson et al. teaches a surface impedance tester for determining the resistivity of metal sheets by injecting a unit-step pulse of current into an exposed surface of the sheet and measuring the surface voltage gradient between a pair of contacts located between the current injection contacts.

U.S. Patent No. 5,284,142 to Goble et al. teaches a three-dimensional impedance imaging process comprising applying special current patterns to the body under test through an array of electrodes attached to the surface and measuring the voltage at each electrode in order to display an approximation of the electric conductivity in the interior of the body.

U.S. Patent No. 5,809,458 to Tamarchenko teaches a method of simulating the response of a through-casing electrical resistivity well logging instrument and its application to determining resistivity of earth formations.

U.S. Patent No. 6,028,440 to Roethig et al. teaches a method for the estimation of voltage drop and current densities in an ASIC power supply mesh.

Lepine et al., "Pulsed Eddy Current Method Developments for Hidden Corrosion Detection in Aircraft Structures" teaches a method for assessing the condition of multi-layered aircraft structures using nondestructive testing in order to characterize hidden corrosion.

Sadiku, "Elements in Electromagnetics" teaches the form of line integrals modeling a vector field around a closed curve.

Caduceus MCAT Review, "Kirchoff's Law" teaches that the current flowing into a junction must equal the current flowing out of the junction.

"Symbols and Units" teaches the SI units for current density and resistivity.

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jeffrey R. West whose telephone number is (703)308-1309. The examiner can normally be reached on Monday through Friday, 8:00-4:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Marc S. Hoff can be reached on (703)308-1677. The fax phone numbers for the organization where this application or proceeding is assigned are

(703)308-7382 for regular communications and (703)308-7382 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703)308-0956.

Marc S Hoff
MARC S. HOFF
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800

jrw
August 6, 2003